
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, TULSA DISTRICT
02811.TD
MAY 97
JSH

TULSA DISTRICT GUIDE SPECIFICATION

NOTE: This section is for either Contractor designed
sprinkler systems or systems designed and shown on the drawings.

SECTION 02811

LAWN SPRINKLER SYSTEM

1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1996) Seamless Copper Water Tube
ASTM D 1785	(1994) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTN D 1527	(1994) Acrylonitrile-Butadiene- Styrene (ABS) Plastic Pipe, Schedules 40 and 80
ASTM D 2241	(1994) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2287	(1992) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D 2464	(1994) Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1994a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2468	(1993) Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1991) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D 3261	(1993) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM F 441 (1995) Chlorinated Poly(Vinyl Chloride)
(CPVC) Plastic Pipe, Schedules 40 and 80

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.18 (1984; R 1994) Cast Copper Alloy Solder Joint
Pressure Fittings

ASME B16.22 (1989) Wrought Copper and Copper Alloy Solder
Joint Pressure Fittings

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1012 (1972; Rev thru Sep 1993) Backflow
Preventers with Intermediate Atmospheric Vent

ASSE 1013 (1971; Rev thru Oct 1993) Reduced
Pressure Principle Backflow Preventers

ASSE 1020 (1974; Rev Feb 1989) Pressure Vacuum
Breaker Assembly (Recommended for Outdoor
Usage)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509 (1994) Resilient-Seated Gate Valves for Water
and Sewerage Systems

AWWA C901 (1988; Errata 1988) Polyethylene (PE)
Pressure Pipe and Tubing, 1/2 In. Through 3
In., for Water Service

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH
(FCCHR)

FCCHR-01 (1988) Manual of Cross-Connection Control

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check
Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (1993) Industrial Control Devices,
Controllers and Assemblies

NEMA ICS 6 (1993) Enclosures for Industrial Control and
Systems

1.2 DEFINITIONS

Diameter of Coverage - diameter of the surface area receiving water
(pertains to full or part circle).

Head:

Bubbler - special head with adjustable flows for deep watering.

Fill-in - heads not located on the basic symmetrical pattern and/or which
may not have the same coverage as the heads in the pattern.

Pop-up - spray or rotary head installed flush with the turf, containing a nozzle which rises above the turf when operating.
Rotary - head containing a nozzle that rotates, discharging a high velocity water stream.
Shrub - spray head designed for installation in or above shrubbery and flowers usually with a small diameter of coverage.
Spray - head containing a nozzle that discharges a fine uniform water spray.
Strip - spray head designed for watering long, narrow strips of turf or landscaping, usually in a square or rectangular pattern.
Header - water line leading off from a zone valve; subject to pressure only when zone is operating.
Lateral - water line leading off from a header to a head.
Main - water line under constant pressure, supplying the sprinkler zones.
Valve:
Throttle - valve used to regulate flow to a zone.
Zone - valve used to activate/terminate flow to a zone.
Zone - a section of heads controlled by one valve.

**NOTE: Delete Paragraph 1.3 and subparagraphs if
system is designed and the layouts and details are
shown on the drawings.**

1.3 DESIGN CRITERIA

1.3.1 General

a. Contractor shall design the system in accordance with industry accepted practice, recommendations of the manufacturer of the equipment provided, and the following requirements. Requirements herein shall prevail.

**The areas to be covered are to be indicated on the
drawings.**

b. The limits of the area to be covered shall be as indicated.

c. Design pressure shall be based onMPa psi static pressure andMPa psi residual pressure at liters per second gpm at the location indicated.

d. System shall be automatic with controller(s) and remote controlled valves.

e. A backflow preventer shall be installed on the sprinkler main between the tie-in to the potable water supply and the first valve off the main.

f. A gate valve shall be installed upstream of the backflow preventer.

g. Fixed pipe risers above grade shall be copper tubing.

h. The sprinkler system shall be designed utilizing pipe sizes, valves, heads, and zone operation time schedules, to assure an economical and operational system with complete and even coverage. Lawn area systems shall be primarily of the spray head type except that pop-up rotary heads may be

used in large open turf areas. Rotor heads shall not be used in areas less than 10.7 35 feet wide.

i. Application rates for spray head zones shall be within 19 mm and 38 mm .75 and 1.50 inches per hour and not less than 6 mm 0.25 inches per hour for rotary head zones.

j. Mains shall be manually drainable.

k. Zones shall be drained automatically.

1.3.2 Head Layout

1.3.2.1 Turfed Areas:

a. Triangular spacing of heads having the same diameter of coverage shall be used as the basic pattern.

b. Maximum spacing between spray heads shall be 60% of the diameter of the listed spray coverage for spray heads, or shall be head to head coverage for rotary heads, or shall be the manufacturer's recommended spacing for a 11 km per hour 7 mph wind, whichever is less.

c. Equal spacing shall be used between heads of the same diameter of coverage on rows and between rows of heads.

d. Part-circle heads, compatible with the basic pattern heads, shall be used at borders between turf areas and buildings, streets, walks, etc. Wasted coverage onto these areas shall be minimized except that spray onto buildings will not be allowed. Sidewalks less than five feet wide with turf on both sides need not be bordered with part-circle sprinkler heads.

e. Fill-in heads shall be used in areas where the basic pattern cannot be maintained or where the pattern is obstructed by trees, shrubs, poles, etc. Future size of plants shall be considered in placing fill-in heads in the latter case. Minimum overlap between fill-in heads and basic pattern heads shall be the overlap between basic pattern heads.

1.3.2.2 Landscaped Areas

a. Spacing of heads shall be as outlined under Turfed Areas. Plants over 600 mm 2'-0" in height shall receive water from at least two sides.

b. Spray shall be above landscaped plantings from pop-up or fixed riser-mounted shrub heads except where plants will exceed 600 mm 2'-0" in height. Future size of plants shall be used for determining height of risers or pop-ups which shall not exceed 600 mm 2'-0".

c. Bubblers shall be provided in landscaped areas where semi-flood watering is required. Throttle valves shall be used to control amount of flooding.

1.3.3 Pipe Sizing

Flow velocities shall not exceed 2.7 m/sec 9 ft/sec for spray head zones and 1.5 m/sec 5 ft/sec for rotary zones. Pressure losses due to meters, valves, backflow preventer, pipe, pipe fittings, elevational differences, etc., shall be used in sizing lines. Pressure available at each head shall be within the minimum and maximum specified by the manufacturer. Total pressure drop between any heads of a spray head zone shall not exceed 30%.

Differential pressure between any heads of a rotary zone shall not exceed 69 kPa 10 psi.

1.3.4 Zoning

Spray and rotary type heads shall not be installed in the same zone. Heads within the same zone shall have matched precipitation rate. Number of zones established shall minimize system operation time within economic reason as to size of pipe and number of operating valves required. A schedule of recommended zone operation times and sequence of operations of the installed system shall be provided upon completion of the work. Separate zones shall be provided for landscaped areas where watering requirements are different from the turfed areas.

1.3.5 Electrical

Each controller shall be connected to a separate, unswitched circuit with its own circuit breaker. Wire size for power supply shall be governed by local codes. Wiring of controllers and valves shall comply with the manufacturer's instructions.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

Design Analysis and Calculations; FIO. Spare Parts; FIO.

Design analyses and pressure calculations verifying that system will provide the irrigation requirements. Calculations shall include pressure losses to and residual pressure for each head in each zone, the difference in pressure between heads, and any other calculations necessary to conformance with manufacturers recommendations and these specifications.

Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than the start of the field tests. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

SD-04 Drawings

Sprinkler System; GA.

Detail drawings for valves, sprinkler heads, backflow preventers, automatic controllers, emitter heads, and water hammer arresters. Drawing shall include of a complete list of equipment and materials, and manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed system layout, type and number of heads and emitters, zone valves, drain pockets, backflow devices, controllers, and mounting details of controllers. As-built Drawings which provide current factual information showing locations of mains, heads, valves, and controllers including deviations from and amendments to the drawings and changes in the work shall be included.

If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and reasons therefor shall be submitted in writing as soon as practicable after contract award to the authorized Government representative for written approval.

SD-06 Instructions

Sprinkler System; FIO.

Detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done.

SD-09 Reports

Field Tests; FIO.

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of control valves.

SD-13 Certificates

Sprinkler System; FIO.

The material supplier's or equipment manufacturer's statement that the supplied material or equipment meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of material supplier or product manufacturer and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

SD-19 Operation and Maintenance Manuals

Sprinkler System; FIO.

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set prior to field testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

Manuals shall show a schedule of the measured or calculated flow rates for each zone, and a recommended controller setting and a schedule of times and duration of operation for each zone for each month or season based on a stated recommended precipitation requirement for the type of turf or plants and the geographical location of the installation.

NOTE: Delete Paragraph 1.5 and subparagraphs if system is designed and the layouts and details are shown on the drawings.

1.5 CONTRACTOR QUALIFICATIONS

The Contractor's firm shall have been in the turf irrigation business for a continuous period of not less than 5 years prior to bid opening. Evidence shall be provided that the firm has designed and installed at least 3 sprinkler projects of similar scope as this project within the preceeding 12 months. In lieu of the above experience the Contractor may provide evidence of at least one of the following qualifications:

- a. Certified Irrigation Designer by The Irrigation Association, Arlington, VA.
- b. Registered Professional Engineer with at least 3 years experience in design and installation of turf irrigation.
- c. Approved designer of the American Society of Irrigation Consultants.
- d. Licensed by the Texas Turf Irrigation Organization, or licensed, certified, or registered by other state turf irrigation organizations, associations, or societies.

2 PRODUCTS

2.1 GENERAL

2.1.1 Standard Products

Products furnished shall be standard products of manufacturers regularly engaged in the production of such products and shall be manufacturers' latest standard design that complies with the specification requirements. Products shall be specifically designed for the intended purpose.

2.1.2 Delivery and Storage

Products delivered to site shall be inspected for damage, unloaded, and stored with the minimum of handling. Do not store products directly on the ground. Inside of pipes and fittings shall be kept free of dirt and debris.

2.1.3 Handling

Products shall be handled in such a manner as to insure delivery to the trench in sound undamaged condition. Pipe shall be carried to the trench, not dragged. Gasket materials and plastic materials that are not to be installed immediately shall not be stored in the direct sunlight. Valves, controllers, sprinkler heads, etc., shall be removed from protective cover only upon installation.

2.2 PIPE AND FITTINGS

Pipe and fittings shall be plastic (PVC, ABS, or PE) or copper tubing. Pipe and fittings shall be rated for a minimum working pressure of 1032 kPa 150 psi and a minimum hydrostatic pressure of 1380 kPa 200 psi.

2.2.1 Copper Tubing

ASTM B 88, type K, annealed. Fittings and specials shall be flared and shall conform to ANSI B16.26.

2.2.2 PVC Plastic

Pipe shall conform to [ASTM D 1785](#), Schedule 40, 80, or [ASTM D 2241](#) (SDR 21), class 12454-B, PVC 1120. Fittings for use with Schedule 80 pipe shall conform to the requirements of [ASTM D 2464](#) or [ASTM D 2467](#). Fittings and joints for SDR 21 pipe shall be elastomeric gasket push-on type. Fittings for schedule 40 pipe shall be solvent weld socket type conforming to [ASTM D 2466](#).

2.2.3 ABS

ABS pipe conforming to [ASTM D 1527](#), Schedule 40 with [ASTM D 2468](#) fittings

2.2.4 Polyethylene (PE)

2.2.4.1 Pipe

Pipe shall conform to [AWWA C901](#), outside diameter base with dimension ratio (DR) of 9.3. Fittings shall conform to [ASTM D 3261](#), DR of 9.3.

2.3 BACKFLOW PREVENTION DEVICE

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be tested, approved, and listed in accordance with [FCCHR-01](#). Backflow preventers with intermediate atmospheric vent shall be in accordance with [ASSE 1012](#). Reduced pressure principle backflow preventers shall be in accordance with [ASSE 1013](#).

2.3.1 Pressure Type Vacuum Breaker

Vacuum breaker shall conform to the requirements of [ASSE 1020](#) and shall be bronze or brass construction, with one or two check valves, vacuum relief, inlet and discharge shut-offs valves, field test cocks, and vacuum relief opening of greater diameter than unit.

2.3.2 Reduced Pressure Type Backflow Preventers

Backflow preventers shall be [1032 kPa 150-pound](#) flanged cast iron, bronze, or brass, mounted gate valve and strainer, 304 stainless steel or bronze, internal parts. Total pressure drop through complete assembly shall be a maximum of [70 kPa 10 psi](#) at rated flow. Piping shall be red brass pipe and fittings. Strainers shall be bronze or brass construction with gasket caps. Units shall have 200-mesh stainless steel screen elements.

2.4 SPRINKLER HEADS

2.4.1 General

Heads shall be constructed of brass or high-impact plastic. Heads shall consist of a body, nozzle, and any parts necessary to the items function.

2.4.2 Rotary

Rotary heads shall be one of the following types: impact drive, gear drive, cam drive, or ball drive. Rotary heads shall be pop-up type.

2.4.3 Spray

Spray heads shall be pop-up or permanent shrub type. Pop-up shall be a minimum of 3« inches in turfed areas and above plantings in landscaped areas.

2.5 VALVES

2.5.1 General

Valves shall be constructed of brass, bronze, a combination of the two, stainless steel, or high-impact plastic except as otherwise specified for valves 3 inches and larger.

2.5.2 Remote Control Valves

Valves shall be electric, 24 V., normally closed solenoid actuated, diaphragm type. Valves shall be equipped with a flow adjustment stem for manual closing.

2.5.3 Gate Valves

Bronze gate valves smaller than 75 mm 3 inches shall conform to MSS SP-80, Type 1, Class 150. Valves 3 inches and larger shall be iron body, bronze mounted and shall conform to AWWA C 509.

2.5.4 Quick Coupler Valves

Valves shall be of metal construction with weighted cover. Cover shall be lockable with two keys furnished for each type of valve provided. Quick coupler valves shall be furnished with two valve keys for hose connection.

2.5.5 Manual Drain Valve

Valves shall be brass or bronze globe valves conforming to MSS SP-80.

2.5.6 Automatic Drain Valves

Valves shall be spring-loaded, plunger type.

2.6 CONTROLLER

Controller shall conform to the requirements of NEMA ICS 2 with 120-volt single phase service, operating with indicated stations, and grounded chassis. Enclosure shall conform to NEMA ICS 6 Type 3R, with locking hinged cover, wall-mounted. Controller shall be programmed for various schedules by setting switches and dials equipped with the following features:

- (a) Adjustable clock monitors.
- (b) 14-day calendar cycle.
- (c) Sequence timer with variable time (independently variable for each zone (station), minimum time limit of not more than 5 minutes and maximum time of not less than 30 minutes for spray zones and 60 minutes for rotary zones.
- (d) Semi-automatic performance: Automatic cycle can be started manually without disturbing clock setting. Reset for the next scheduled operation after completion of the manual-initiated cycle shall be automatic.
- (e) Manual operation of each zone (station), at random or in sequence independent of the automatic timer.

- (f) Master switch which can prevent the automatic cycle from starting without affecting the pre-set program.
- (g) Zone (station) omit: Zones can be omitted from the automatic or semi-automatic watering cycle.
- (h) Compact design with all programming and operational settings easily made with switches, knobs, keyboard, etc., on the face.
- (i) Instructions for field servicing.
- (j) List of repair parts and their availability.
- (k) Controller and automatic valves shall be provided from same manufacturer.

Dual programming may be needed to allow a station to be omitted from the watering cycle on any day of the program. Usually used to allow less frequent watering of shrubbery areas.

[(1) Dual programming which allows any zone to be omitted from the automatic or semi-automatic cycle on any day or days of the calendar program.]

- (m) Automatic rain shutoff device.

2.7 CONTROL WIRES

Electrical control wires shall be type UF or TW, U.L. approved. Wire shall be minimum 14 gage with common ground.

Concrete valve boxes may be desirable in areas subject to tractor mowing or traffic of some kind. Lockable covers should be provided if required by the using facility.

2.8 VALVE BOXES

Boxes shall be [high impact-strength plastic] [precast concrete with cast iron cover and frame]. [Boxes shall have a lockable cover. [Two] [.....] keys shall be furnished with the system for each type of box provided.]

2.9 EXTRA STOCK

The following extra stock shall be provided: Two sprinkler heads of each size and type, two valve keys for operating manual valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, and four irrigation controller housing keys.

3 EXECUTION

3.1 INSTALLATION:

3.1.1 Trenching

Sprinkler mains, laterals, and control wires shall be installed in common trenches wherever possible. Wiring shall be separated from metal pipe a minimum of 150 mm 6-inches to avoid possibility of current leakages and short circuits. Trenching shall be performed as specified in SECTION: [EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS] [EARTHWORK]. Mains shall be installed a minimum of 600 mm 24 -inches below finished grade. Headers and laterals shall be a minimum of 300 mm 12-inches below finished grade. Soft, spongy, or otherwise unstable material that will not provide a firm foundation for the pipe shall be removed and replaced with satisfactory fill material as defined therein.

3.1.2 Backfilling

After piping has been tested according to paragraph TESTING, trenches shall be cleared of trash and debris. Material for backfilling shall be satisfactory fill material, properly moistened to obtain optimum compaction and compacted by hand or machine tampers to density of undisturbed adjacent earth or compacted fill.

3.1.3 Piping

3.1.3.1 General:

Joints connecting pipe of differing materials shall be made in accordance with the manufacturer's recommendations using approved transition fittings or procedures.

Insulating joints shall be installed between non-threaded ferrous and nonferrous metallic pipe, fittings and valves. Insulating joints shall consist of a sandwich-type flange insulating gasket of the dielectric type, insulating washers, and insulating sleeves for flange bolts. Insulating gaskets shall be full faced with outside diameter equal to the flange outside diameter. Bolt insulating sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure. Dielectric unions shall be encapsulated in a field-poured coal-tar covering, with at least 3 mm 1/8-inch thickness of coal tar over all fitting surfaces.

3.1.3.2 Flushing

When the pipe lines are connected and the sprinkler risers in place, but before any heads are installed, the control valves shall be opened and the full head of water used to flush out the system.

3.1.3.3 Crossings

Piping shall be jacked or pulled under existing paving wherever possible to prevent cutting of pavement. Where cutting is necessary, pavement shall be cut smoothly to straight lines 150 mm 6 inches wider than the trench.

Pavement shall be replaced in accordance with the applicable specifications or as approved. Jacking or pulling of plastic pipe shall not abrade or groove the pipe.

3.1.3.4 Pitch

Mains shall be pitched down not less than 6 mm 1/4 inch in 2.5 meters 10 feet in the direction of drainage valves. Laterals and headers shall be pitched toward the automatic drain valves at not less than 3 mm 1/8 inch in 2.5 meters 10 feet.

3.1.3.5 Copper

Joints shall be compression-pattern flared. The flared end tube shall be pulled tightly against the tapered part of the fitting by a nut which is part of the fitting, so there is metal-to-metal contact.

3.1.3.6 PVC

Pipe shall be installed in accordance with manufacturer's instructions or as hereinafter noted.

Threaded joints shall be made with Schedule 80 pipe only. Threaded joints shall be made using a non-lubricating, non-hardening joint sealing compound as recommended by the manufacturer. Thread tape shall not be used. Joints shall be tightened to not less than one nor more than two turns past finger tight.

Elastomeric-gasket push-on joints shall be made in accordance with ASTM D 3139 and the manufacturer's instructions

Solvent cement joints shall be made in accordance with ASTM D 2855 and the manufacturer's instructions.

3.1.4 Backflow Prevention Device

Backflow prevention device shall be installed in accordance with the applicable paragraphs of the National Standard Plumbing Code.

3.1.5 Sprinkler Heads

Sprinkler heads shall be flush with or not more than 50 mm 1/2 inch above finished grade upon completion of grading, seeding or sodding, and rolling of grass areas. Adjustable risers may be used to accomplish this adjustment.

3.1.6 Valves

Gate valves, remote control valves, and manual drain valves shall be installed with extension valve boxes with tops set flush or not more than 50 mm 1/2 inch above finished grade. Manual drain valves shall drain into sump pits made of gravel, sufficiently large in size to accommodate the volume of water released.

Automatic drain valves shall be furnished at all low points within a zone but no closer than 300 mm 12 inches from the last head. Valves shall be installed at 45 degrees below horizontal into a gravel sump or as recommended by the manufacturer. Sump shall be of sufficient size to accommodate the water released.

3.1.7 Controller

Controller shall be installed at the location shown.

3.1.8 Control Wiring

Control wiring shall be sleeved in plastic or galvanized steel conduit beneath sidewalk or pavement. The conduit shall extend 300 mm 12 inches beyond the edges. Wiring shall be installed a minimum of 300 mm 12 inches below finished grade to the side of or below piping where possible. All main line piping shall have two spare wires installed its entire length and to the automatic controller.

Looped slack at valves shall be provided for electrical wiring. Wires shall be snaked in trenches and shall be tied in bundles at 2.5 meters 10 feet intervals.

Electrical control wire splices shall be allowed only on runs more than 127 meters 500 feet long.

3.2 TESTING

3.2.1 Notification

Contracting Officer shall be present at all phases of testing and shall be notified 24 hours in advance of testing.

3.2.2 Hydrostatic Testing

Water piping and valves shall be tested to a hydrostatic pressure of 689 kPa 100 pounds per square inch before piping is covered with earth. Piping must be tight at this pressure. Piping may be tested in sections to expedite the work.

3.2.3 Final Testing

Final testing shall show proper operation of all components and actual measured application rates at representative and selected locations.